



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL RISK MANAGEMENT RESEARCH LABORATORY
GROUND WATER AND ECOSYSTEMS RESTORATION DIVISION
P.O. Box 1198 Ada, OK 74820

April 29, 2015

OFFICE OF
RESEARCH AND DEVELOPMENT

MEMORANDUM

SUBJECT: Arkwood Superfund Site (15-R06-002)

FROM: Scott G. Huling, Environmental Engineer
Applied Research and Technical Support Branch

TO: Stephen L. Tzhone, Remedial Project Manager
Superfund Division
EPA Region 6, Dallas TX

A technical review was conducted on the document entitled, "Supplemental Groundwater Tracing Summary Report Arkwood, Inc. Superfund Site, Omaha, Arkansas", prepared by Ozark Underground Laboratory (March, 2015).

It was inferred in the report that New Cricket Spring captured the injected tracer and that the uncaptured residual tracer was detained within the immobile porosity associated with the porous media. In addition to these fate mechanisms, an additional fate mechanism not evaluated nor considered in the tracer fate and transport assessment is that some of the tracer in the ground water could have migrated laterally and bypassed the capture zone created by the naturally occurring spring. Multiple lines of evidence presented in this report and in previous reports, indicate that a ground water flow divide exists on site resulting in multi-directional ground water flow. Consequently, multiple contaminated ground water flow directions away from on-site waste management areas would occur and complete capture by the New Cricket Spring is projected to be unlikely. Ground water flowing beneath the waste management area located on the north side of the property, adjacent to the train tracks, would be particularly vulnerable in avoiding capture given that it flows in nearly the opposite direction of the spring. It is recommended to re-evaluate the feasibility of the New Cricket Spring ground water treatment system to fully capture all of the contaminated ground water emanating from the area encompassed by the Arkwood Superfund site. If I can be of assistance to you, please call me at (580) 436-8610.

cc: Ed Gilbert (5203P)
Terry Burton, Region 6
Gregory Lyssy, Region 6
Vince Malott, Region 6

Technical Review Comments and Recommendations:

General Comments

1. *1.4 Previous Groundwater Tracing Study*, Pg. 5. It was reported that one trace was introduced at the “woodchip pile” at the southeast corner of the site, and that “The 1991 tracing demonstrated that the Site was underlain by a groundwater divide. Groundwater from the southeastern portion of the Site discharges to the Walnut Creek topographic basin and groundwater from the northwestern portion of the Site discharges to the Cricket Creek topographic basin.” This is an important aspect of the tracer study, and the overall feasibility of the New Cricket Spring to fully capture contaminated ground water at the Arkwood site.

The ground water flow divide conceptual model is supported by Figure I-7 of Appendix D (Revised Final Tracer Workplan), where it is evident that ground water in the eastern portion of the site flows approximately to the north (i.e., as a result of the 91-01 dye tracer study), and the results of the 14-01 and 14-02 tracer study suggest that ground water in the central portion of the site, near the sinkhole, flows generally to the west.

Further support of this conceptual model was provided by data and information in the Remedial Investigations Report (Vol. 1 and II), Arkwood Inc. Site (March 3, 1990). Given that (1) the water table data are available from a limited number of wells, (2) significant topographic relief across the study area occurs, and (3) several hydrogeologic/lithologic zones exist at the site, judicious data interpretation of the ground water levels and flow direction should be exercised. Water table isocontours indicate that the on-site ground water flow direction is complex and involves multi-directional flow (Figures 4-36a, b, and c). It is also reported that the mapped elevations of the water table reflect the surface of a discontinuous water table (page 4-40). The multi-directional ground water flow is consistent with a “flow-divide” that occurs in all three figures and is also consistent with a perched aquifer condition. Installation of several wells during the previous ground water investigation occurred in low permeable media. A layer of low permeability is one of the conditions that is typically found in a “perched aquifer”. Wells screened in this zone are also prone to be pumped dry. Assuming this hydrologic conceptualization is accurate, flow directions are projected to be time-dependent as they reflect periodic precipitation inputs. Periodic inputs of PCP contaminated ground water may also result from rainfall events. The projected ground water flow directions in the area of MW-9 and 11 (across the tracks) suggest that these wells are further upgradient, that flow is northward towards the railroad tracks, and that this explains the lack of contamination in the MW-9 and -11 area.

Multiple lines of evidence are consistent with a ground water flow divide hydrologic conceptual model. Therefore, the on-site multi-directional contaminated ground water flow directions are unlikely to be captured by the New Cricket Spring located off site on the west side of the facility. Given this preliminary assessment of the data and information, it appears unlikely that capture of all the contaminated ground water by New Cricket Spring has been attained. It is recommended to re-evaluate the feasibility of the New Cricket Spring ground water treatment system to fully capture all of the contaminated ground water emanating from the area

encompassed by the Arkwood Superfund site.

2. Please explain how the dye extracted from the activated carbon was extrapolated back to ground water concentrations.

Specific Comments.

1.1 Purpose and Scope of Study, Pg. 3. It was reported that “Such a trace would provide data about water movement from that portion of the Site most heavily impacted by historical operations to New Cricket Spring, the location where contaminated groundwater emanating from the Site discharges to the surface.”

In a previous memo to EPA Region 6 (June 20, 2014) regarding the proposed workplan for the tracer test, it was noted that it appears there were two main areas where waste management activities occurred, (1) in the former sinkhole location, and (2) on the north side of the property where creosote and PCP/non-aqueous phase liquids (NAPLs) were managed. To more appropriately trace contaminant transport from the site (i.e., not only the former sinkhole area), it was recommended to consider the additional release of a tracer in the former wood storage/process areas where a significant release of waste residuals is known to have occurred (trolley/treatment area). For example, wells MW-4, 5, 8, and 10 located just north of the Arkwood site appeared to have been contaminated as reported in the RI. These wells are off site and are in the low-lying area adjacent to the railroad tracks. The alternative approach was recommended to release a tracer in the nearby process area and include these wells, and possibly others in the tracer test. Previously, the tracer test location conducted in 1991 (91-01) was initiated in the southeastern area of the site and that tracer test results indicate no dye was measured in New Cricket Spring (sample location #17). However, dye was measured in numerous locations on the north side of the site suggesting that ground water located in the southeast area of the site moved to the north, not to the west towards New Cricket Spring. This information underscores the importance of developing a better understanding of contaminant transport in other process areas, in addition to the former sinkhole.

Apparently the updated tracer test conducted in 2014 was conducted in a manner that did not recognize the recommendation and that tracer test results were only available regarding the former sinkhole area. Therefore, no additional information is available regarding the north side of the property where creosote and PCP/non-aqueous phase liquids (NAPLs) were managed.

1.3 Hydrogeologic Setting, Pg. 4. It was reported that , “The semi-quantitative dye tracing investigation discussed in this report provides a valuable on-Site measurement of the percent of mobile porosity existing in the most impacted portion of the shallow epikarstic zone aquifer at the Arkwood Site.” It does not appear that the procedurs used to estimate the percent mobile porosity based on the results of the tracer tests was provided. It is recommended that the report be revised to include this information.

2.2.1 Types of Samples, Pg. 8. It was reported that, “Composite water samples were collected to permit a mass balance calculation for each tracer dye. This information permits a

measurement of the percent of mobile porosity in the portion of the epikarstic aquifer lying between the former sinkhole and New Cricket Spring.” It should be specified what calculations were used to estimate “mobile porosity”.

2.3 Laboratory Analyses, Pg. 12. It was reported that activated carbon samples were rinsed under a relatively strong jet of water, eluted in a standard eluting solution, and that water samples were pH adjusted to raise the pH of the water to 9.5 or higher. In review of Appendix A, it was reported that the elution solution is typically comprised of an alcohol, water, and a strong basic solution such as aqueous ammonia and /or potassium hydroxide. It is recommended that information be provided regarding the extent to which a mass balance could be achieved in the complete removal of the dyes from the carbon as a control sample.

3.2.1 Trace 14-01: Former Sinkhole Area Well A. Fluorescein Trace. Pg. 16. The presence of fluorescein dye in the Cricket Pond suggests that the New Cricket Spring did not capture all of the tracer-amended ground water that left the Arkwood site. Please elaborate on this matter.

3.3.2 Mass Balance Calculations, Pg. 22.

1. Pg. 22. It was reported that the mass balance calculations showing the incremental mass of dye recovered in New Cricket Spring (i.e., flow \times concentration \times time) are included in Appendix C. This information was not included in Appendix C. It is recommended that the calculations be provided showing the mass balance calculations.

2. Pg. 22. It was reported that “The technical literature suggests that dye traces from sinkholes to springs are typically characterized by 20 to 50% of the introduced dye being detected at the receiving spring (Aley1997). The detection percentages from this study are within the reported range.” The potential array of possible testing conditions that could occur for a specific tracer test is broad and dependent on many site variables. Therefore, it does not seem prudent that the range of recovery reported (20-50%) should serve as a quality assurance or quality control metric.

3. Pg. 22. It was reported that “The detection percents for the two dye traces (45% for fluorescein and 38% for rhodamine WT) provide a measure of mobile porosity in the most contaminated portion of the groundwater system at the Arkwood Site.” Please clarify how the mobile porosity was calculated from the dye tracer test results.

4. Pg. 22. It was reported that the dye that was not recovered was detained within the non-mobile portion of the epikarstic aquifer. An additional tracer fate mechanism that was not investigated or discussed involves the transport of the tracer beyond the capture zone of the New Cricket Spring. Specifically, under this condition the tracers would bypass the capture zone of the spring. Please clarify why it was inferred that the unrecovered dye did not simply bypass the New Cricket Spring.

5. Pg. 23. It was reported that the difference between the travel times of the fluorescein

and the Rhodamine WT dyes was due to the potential sorption mechanisms of the latter dye. Fluorescein and Rhodamine WT dyes were injected into wells A and B, respectively (both screened 15-25 ft bgs). However, fluorescein was not detected in well B, and was essentially non-detect or very low in other 7 nearby wells (C, G, H, I, J, K) (Table 1, Appendix B), and the Rhodamine WT dye injected into well B was not detected or was detected at very low concentrations in wells D, E, H, I, and J (Table 1, Appendix B). Injection of these dyes was followed by the injection of a large volume of clean water that helped to distribute the tracer beyond the sand packs in these wells. These results suggest heterogeneous ground water flow paths exist in the subsurface within a relatively small plan view area. Given the known heterogeneity of the subsurface, it is reasonable to assume that differences in dye recovery could also be attributed to different flow paths which could lead to differences in the degree of dye recovery in, and bypassing of the New Cricket Spring.

Section 4, Summary and Conclusions. It was reported the fate of the dye is either (1) that it was captured by the New Cricket Spring or, (2) that it was “detained in the immobile porosity of the epikarstic aquifer”. Dye transport into immobile pores could take months and years. But in this case, the tracer test lasted 7 weeks and peaked at the New Cricket Spring within 8-10 hours of injection allowing limited time for diffusive transport. No data or information was provided to suggest that the lack of dye recovery is that it could have bypassed the New Cricket Spring. It appears that the hydrologic conceptual model suggested in this report is that all the ground water associated with the western portion of the site, and possibly all of the ground water underlying the site, is captured by the New Cricket Spring. This does not seem to be justified.

Due to various lines of evidence, a direct conduit between the sinkhole and the New Cricket Spring has been established. At the outset of the tracer test, it was unclear however, whether the spring would fully capture the entire mass of tracer injected into the sinkhole area. Based on the results of these tracer tests, it does not appear prudent to conclude that the New Cricket Spring captures all the contaminated ground water passing from the sinkhole area. Previously, it was recommended that the tracer test be conducted in a manner in which different portions of the site be tested (i.e., tracer test be released) where waste management activities were tested, not just the sinkhole area. Consequently, conclusions are not possible regarding the extent to which New Cricket Spring captures contaminated ground water passing through other areas of the site.